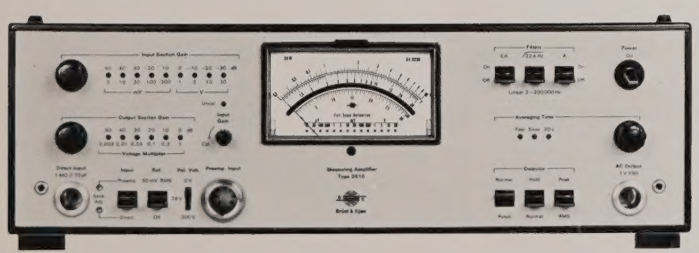
2610

Instruction Manual

Measuring Amplifier Type 2610



A wide range calibrated amplifier-voltmeter with linear frequency response from 2 Hz up to 200 kHz, featuring interchangeable meter scales for sound, vibration and voltage measurements. It has sensitivity ranges from 10 μV to 30 V (+ 100 to —30 dB) FSD with LED indication of measurement range, gain, and input and output overload. Its meter indicates true RMS as well as Max. Peak levels for signals with crest factors up to 20 (10 at FSD) and has Max. Hold, plus Fast, Slow and 20 s averaging functions. 22,4 Hz high pass and A-weighting networks are built-in, including facilities for connection of external filters. Also included are Direct and Preamp. Inputs with 0, + 28 and + 200 V microphone polarization, plus wide range AC Lin and DC Log Outputs.
When used with a suitable B & K Condenser Microphone and Preamplifier combination, the 2610 serves as a high grade precision sound level meter in accordance with Type 0 requirements of IEC R 651.

Brüel & Kjær

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MEASURING AMPLIFIER
TYPE 2610

(Applicable to instruments from serial No. 863635

Revision May 1980

This apparatus has been designed and tested according to Class II of IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The present Instruction Manual contains information and warnings which should be followed by the user to ensure safe operation and to retain the apparatus in safe condition.

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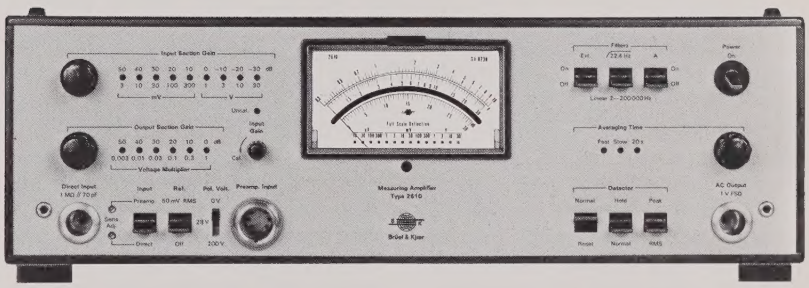
type 2610

Wide Range Measuring Amplifier

USES:

- High grade precision sound level meter. With B & K condenser microphones complies with Type O requirements of IEC R 651
- Versatile vibration meter with B & K piezoelectric accelerometers and other vibration transducers
- Wide range, low-noise electronic voltmeter
- Frequency analysis with B & K band pass filter sets
- Low noise amplifier with calibrated gain from —30 to +110 dB in accurate 10 dB steps



FEATURES:

- Overall frequency range from 2 Hz up to 200 kHz (±0,5 dB)
- Measuring ranges from 10 μV to 30 V FSD, selectable in accurate 10 dB steps
- Accurate true RMS indication for AC signals with crest factors up to 10 (up to 20 below FSD)
- Accurate Max. ± Peak indication for signals of 50 μs or longer
- Max. Hold mode for Peak and RMS measurements
- "Fast" and "Slow" time weighting, plus "20 s" averaging time
- Interchangeable meter scales with linear dB and logarithmic voltage ranges for sound, vibration and voltage measurements
- Automatic indication of gain, measuring range and overload
- Accurate 50 mV, 1 kHz reference source for calibration
- Selectable 22,4 Hz high pass and A weighting networks
- Direct and Mic. Preamp inputs with 0; 28 and 200 V Mic. polarization voltage
- Wide range AC and DC outputs for recording
- Provision for connection of external filters for frequency analysis

Introduction

The B & K Measuring Amplifier Type 2610 is an easy to use calibrated amplifier — voltmeter featuring extreme versatility, wide measurement range and laboratory precision. It may be used alone or as the basis around which numerous measurement and analysis set-ups may be built for investigation of sound, vibration and voltage signals. Used with one of the B & K Condenser Microphones and Preamplifiers which are available it serves as a high grade precision sound level meter conforming with Type O requirements of IEC R 651, DIN 45633 (part 1) and ANSI S1 4-1971 (Type 1).

Description

Multi-Purpose Inputs

The 2610 is furnished with two alternative AC coupled signal inputs

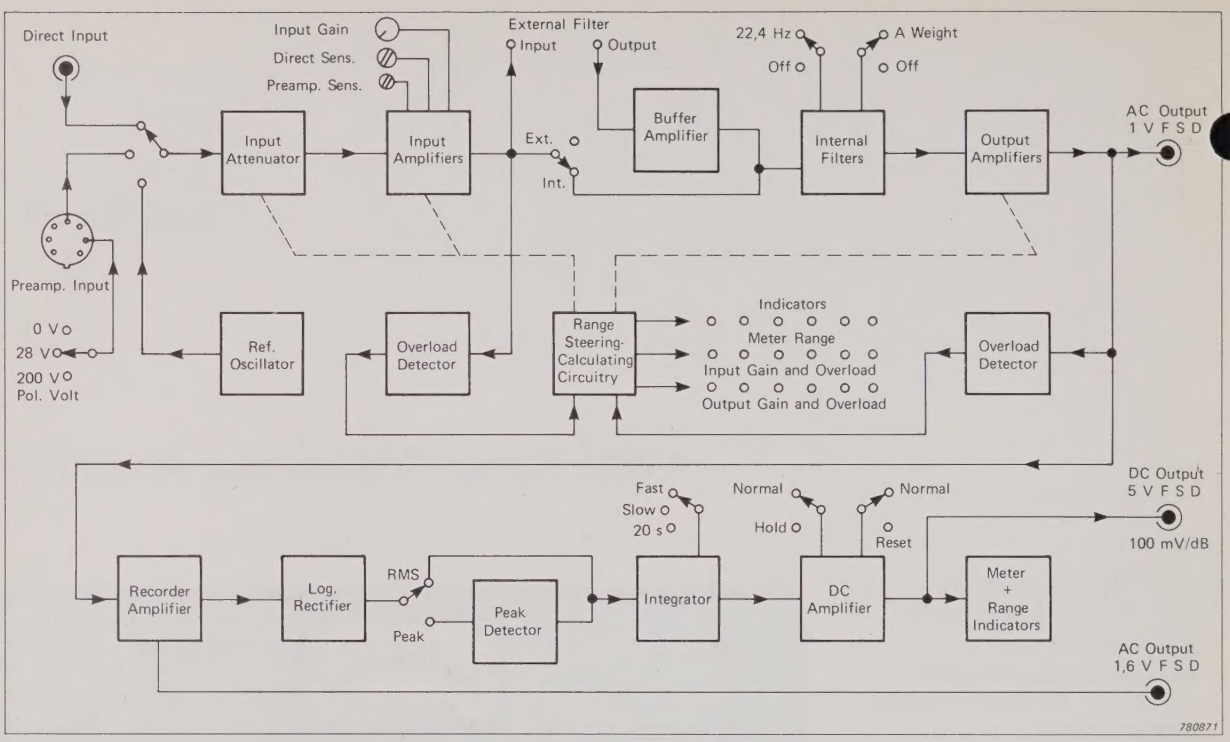


Fig.1. Block diagram of the 2610

— a Direct Input which accepts standard B & K coaxial plugs and is used for voltage and vibration measurements etc., and a Preamp. Input which accepts the 7 pin plug of B & K Microphone Preamplifiers for sound measurements. Both inputs have a high input impedance of 1 MΩ in parallel with 70 pF and can withstand voltages as high as 220 V (50 Hz) AC or 400 V DC without damaging the instrument.

Besides serving as a signal input, the Preamp. Input supplies stabilized voltages for powering B & K Microphone Preamplifiers. Just beside the input is a switch for selection of +28 V and +200 V polarization necessary for operation of condenser microphones. Also included is a "0 V" polarization setting for operation with prepolarized microphones.

The Direct and Preamp. Inputs are each equipped with their own individual screwdriver accessible sensitivity adjustment. These adjust the gain of the input amplifier facilitating calibration of the 2610 for a wide range of transducer sensitivities.

To save using an external reference source for calibration, the 2610 has its own built-in. This may be switched connecting it to either the Direct or Preamp. Input and produces a stabilized 50 mV, 1 kHz sinus signal. Apart from aiding precise adjustment of the sensitivity of the 2610 to obtain a direct meter reading for sound, vibration and voltage measurements, it is also useful in calibrating magnetic tape and graphic recording equipment used with the Measuring Amplifier.

Amplifier Sections

The particular combination of cascaded amplifier stages with staggered amplification and attenuation, gives the 2610 particularly good signal amplification linearity with very low noise and distortion. The nominal overall amplification and attenuation is from 100 to —30 dB and may be switched in accurate 10 dB steps to give voltage measurement ranges from 10 μV to 30 V for full scale deflection on the meter. Switching may be accomplished using the Input and Output Section Gain knobs on the front panel, or may be steered remotely via a pair of multi-pin sockets inside the instrument. Three separate rows of indicator lights automatically show which particular gain settings and measurement range are selected.

For measurement of very low signal levels such as when employing external filters with the 2610, an extra 0 to +10 dB of continuous gain adjustment can be obtained by adjusting the Input Gain knob of the instrument. Alternatively, for measurement of signals up to 300 V a BNC Adaptor JP 0144 plus 10:1 attenuator probe ZC 0016 (not supplied) can be used with the Direct Input.

Overload Warning

For a reliable overload warning the input and output amplifier sections of the 2610 have separate overload detectors. These are of particular help when using weighting networks or external filters with the Measuring Amplifier, as overload by signals outside the filter pass band can sometimes produce a misleading meter indication.

The two overload detectors respond to positive and negative signal peaks as short as 200 μs and once triggered cause the appropriate gain indicator lights of the 2610 to flash. The lights continue to flash for a minimum period of 0,5 s, thus enabling very short duration over-

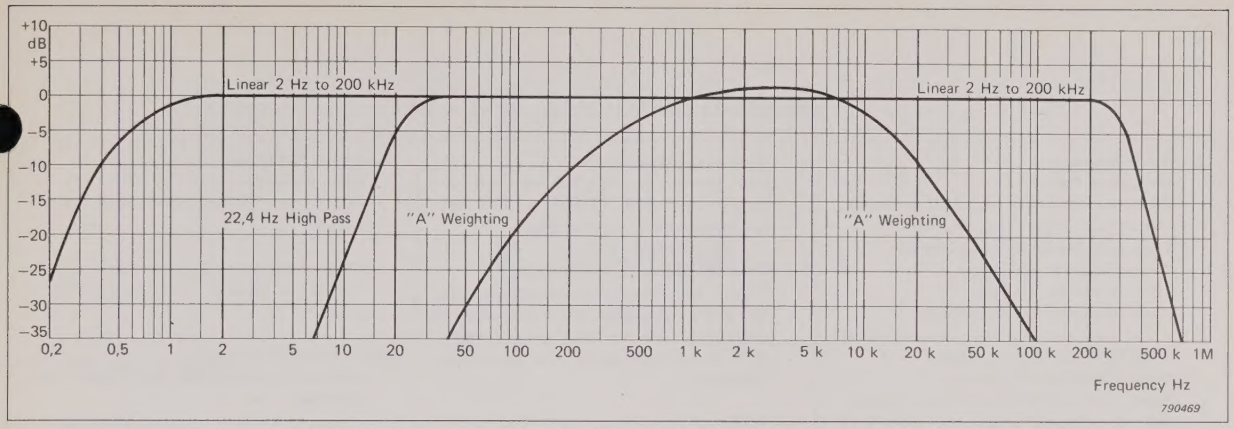


Fig.2. Overall frequency response of the 2610 with and without its internal frequency networks selected.

loads to be spotted. To suit the maximum input voltage requirements of different external filters which may be employed with the 2610, the trigger level of the input overload detector may be switched so that it is equivalent to 5 to 10 times full scale deflection on the Measuring Amplifier.

Filter Section

The filter section includes a 22,4 Hz high pass filter and an "A" weighting network, these being the two most frequently used frequency networks employed for sound measurements. The 22,4 Hz high pass filter has a low frequency attenuation slope of 18 dB / octave and is useful in limiting the influence of unwanted low frequency environmental disturbances, while the "A" weighting network is used to obtain a subjective meter indication of the loudness of measured sounds and complies with IEC R 651 (Type O) for precision sound level meters. Their influence on the overall frequency response of the Measuring Amplifier is shown in Fig.2.

In addition to the above frequency networks, facilities are provided for connection of external filters. Suitable types are the B & K Third Octave and Octave Band Pass Filters Types 1617 and 1618, the Tunable Band Pass Filter Type 1621, the Tracking Filter Type 1623 and the Heterodyne Slave Filter Type 2020. These may be used with or without the internal frequency networks selected and enable frequency analyses to be performed with the 2610, thus permitting sound, vibration and voltage signals to be investigated in very great detail.

Rectifier and Meter Section

The 2610 has a logarithmic meter response with RMS and Peak indicating modes which permit all commonly encountered signals to be accurately measured including those with complex random waveforms. A wide range Log. Rectifier with dynamic range of over 70 dB is used to perform the necessary signal rectification which with subsequent processing by a special integrator circuit provides a true RMS meter indication with accuracy better than ±0,5 dB (±0,2 dB typical) for signals with crest factors up to 10 at full scale and up to 20 for lesser deflections. The integrator has selectable time constants enabling "Fast" and "Slow" time weighting characteristics in accordance with Type O requirement of IEC R 651 for precision sound level meters to be selected. In addition a "20 s" effective averaging time may be chosen which is beneficial for measurements and analysis using narrow band filters with the 2610.

For a peak indication the Log. rectified signal is applied to a Peak Detector. This detects the maximum peak value (positive or negative whichever is the greatest) of the input signal and has a typical rise and decay time of 50 μs (1,7 dB/μs) and 0,2 s respectively so as to provide an accurate, easy to read meter indication with fast changing signal levels. To facilitate measurement of transient signals and very short duration events a "Hold" mode may be selected enabling their maximum peak and RMS value to be captured and displayed on the meter. The decay of the meter reading in this mode is less than 0,2 dB / minute (i.e. 0,003 dB/s). For resetting the meter reading a reset mode is provided.

Meter Scales

To facilitate direct reading of measured sound, vibration and voltage levels, the meter of the 2610 has a row of range indicating lights and is supplied with interchangeable scales (see "specification" section). Scales for sound measurements have a linear 30 dB SPL range for reading of sound pressure level, plus a mV/Pa range which enables the 2610 to be calibrated for different microphone sensitivities. For voltage and vibration measurements scales have logarithmically calibrated ranges in V and ms^{-2}, as well as a linear dB range. Special scales can be made up using a blank scale SA 0082 which is available, or alternatively they can be made to order.

Outputs

The 2610 has three calibrated signal outputs — two AC and one DC. These may be used to feed magnetic tape as well as level and X-Y recording equipment, thus enabling a permanent hard copy record of measurements and analyses to be obtained. The AC outputs provide an amplified (and if connected-filtered) version of the input signal, while the DC output produces a rectified and averaged DC voltage proportional to the measured dB value indicated by the meter. The dynamic range of the outputs is better than 100 dB and 60 dB respectively.

Specifications 2610

Amplifier Response:

Measuring Range:
10 μV to 30 V FSD with LED indication of particular meter range selected
Frequency Range (without filters):
2 Hz to 200 kHz (±0,5 dB)
10 Hz to 50 kHz (±0,2 dB)
Phase Deviation (without filters):
≤ ±5° between any two instruments in range from 20 Hz up to 20 kHz
Overall Gain (for 1 V output):
From —30 to +100 dB selectable in accurate 10 ±0,05 dB steps, plus extra 0 to 10 dB gain for continuous adjustment between steps. LED indication of particular input and output gain setting selected

Direct Input:
Via standard B & K coaxial socket
Impedance: 1 MΩ || 70 pF
Max. Input Voltage: 42 V RMS in accordance with IEC 348, but can withstand test voltages up to 220 V AC (50 Hz) and 400 V DC

Preamp. Input:
Via standard B & K 7 pin microphone preamplifier socket. 0; +28 and +200 V microphone polarization can be selected

Filter Modes:
22,4 Hz: High pass filter with low frequency attenuation slope of 18 dB/octave (60 dB / decade)
A Weighting: In accordance with IEC 651 (Type O) for precision sound level meters
Ext: Provision for connection of external filters in series with one or both internal filters

Ext. Filters:
Provision for connection of external filters via two BNC sockets on rear panel
To (Ext. Filter) Input: 1 V RMS nominal, 10 V peak max. output. Max. load 5 kΩ || 200 pF
From (Ext. Filter) Output: 1 V RMS nominal, 10 V peak max. input. Input impedance 1 MΩ || 50 pF

Meter Indication:
Moving coil meter with interchangeable meter scales and LED indication of particular FSD measurement range selected

Measurement Ranges:
10 μV to 30 V FSD selectable in accurate 10 ±0,05 dB steps

Indicating Ranges:
0,3 to 10 V and 1 to 30 V logarithmic range plus 0 to 30 dB linear range
Indicating Modes:
True RMS with accuracy better than ±0,5 dB (±0,2 dB typical) for signal crest factors up to 10 at full scale, or up to 20 for lesser deflections
Max. (positive or negative) peak with accuracy better than ±0,5 dB (±0,2 dB typical) for signals as short as 50 μs

Time Weighting Characteristics:
"Fast" and "Slow" in accordance with IEC R 651 (Type O), plus 20 s effective averaging time for RMS measurement. 0,2 s decay time constant for peak measurements

Hold:
Meter and DC output hold Max. RMS or Max. Peak level of measured signal. Hold decay < 0,2 dB / min at 25°C

Reset: Reset button for meter and DC output

Overload Indication:
Gain indicator LEDs blink when the input and (or) output section of the 2610 are overloaded by positive or negative signal peaks of too high a level

Overload Level: Equivalent to 5 or 10 times FSD on meter. Level selected using switch on rear panel

Min. Overload Duration: 200 μs
Duration of Warning: 0,5 s or longer

Reference Voltage:
Signal: 50 mV RMS (~ 94 dB re 1 μV), 1 kHz sinus
Amplitude Stability: Better than 2% between +5 and +40°C

AC Outputs:
From output section amplifier via standard B & K coaxial socket on front panel

Output Voltage: 1 V RMS re FSD, 10 V peak max with max load of 10 kΩ || 200 pF

Output Impedance: ~100 Ω

From Recorder Amplifier via BNC socket on rear panel

Output Voltage: 1,6 V RMS re FSD, 16 V peak max. with max. load of 10 kΩ || 200 pF

Output Impedance: ~50Ω

DC Output:
From RMS and Peak Rectifier via BNC socket on rear panel
Output Voltage: 100 mV/dB, 5 V DC re FSD, 7 V (10 mA). max.
Output Impedance: ~50 Ω
Dynamic Range: RMS +20 to —50 dB re FSD. Peak +20 to —40 dB re FSD

Harmonic Distortion:
Input Section: <0,01% at 1 kHz
<0,1% at 50 kHz. Max. load 5 kΩ || 200 pF

Output Section: <0,1% at 1 kHz
<0,3% at 50 kHz. Max. load 10 kΩ || 200 pF

Noise Referred to Input:
Maximum amplification with input short circuited

Input Section: < 5 μV RMS (Lin 2 Hz to 200 kHz). <1,5 μV RMS (A weighted)

Output Section: ≤ 31,6 μV (2 Hz to 200 kHz)

Power Requirements:
100, 115, 127, 200, 220, 240 V ±10% (50 to 400 Hz) AC ~25 VA.
Complies with safety class 2 of IEC 348

Temperature Range:
Operation: +5 to +40°C (+41 to +104°F)
Storage: —25 to +70°C (—13 to +158°F)

Humidity:
0 to 90% relative humidity

Cabinet:
Supplied as model A (light-weight metal cabinet), B (model A in mahogany case), or C (as A but with flanges for standard 19 inch racks)

Dimensions (A cabinet):
Height: 133 mm (5,2 in)
Width: 430 mm (16,9 in)
Depth: 200 mm (7.9 in)

Weight (A cabinet): 5,2 kg (11,5 lb)

Meter Scales Included:

Voltage and dB scale	SA 0238
dB SPL (28 - 89 mV/Pa) scale	SA 0252
dB SPL (5 - 16 mV/Pa) scale	SA 0253
ms^{-2} universal scale	SA 0250

See General Accessories Product Data for other scales available

Accessories Included:

1 Power cable	AN 0020
2 BNC plugs	JP 0035
2 B & K coaxial plugs	JP 0101
2 Banana plugs	JB 0002

Accessories Available:

B & K to BNC Input Adaptor	JP 0144
10:1 Input Probe	ZC 0016

2. CONTROLS

2.1. FRONT PANEL

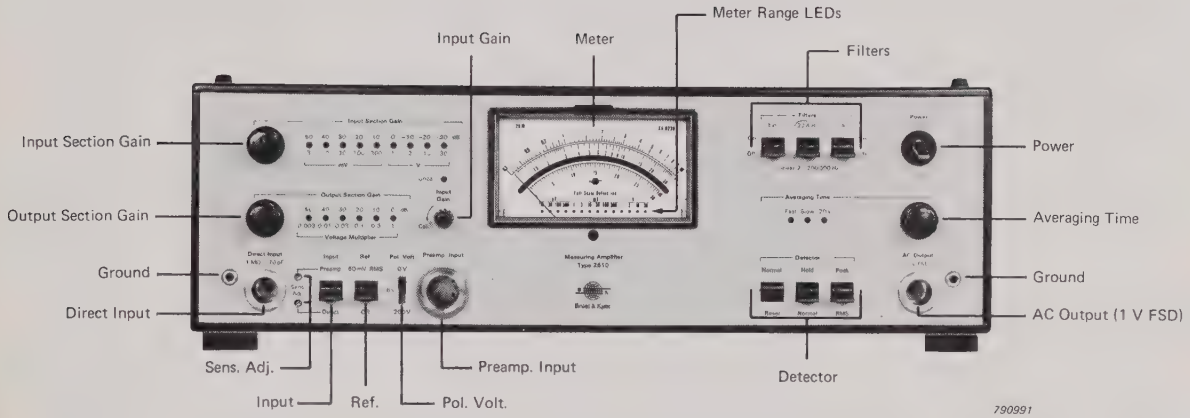


Fig.2.1. Front panel of the 2610 Measuring Amplifier

POWER: "On/Off" toggle switch for mains power. When set to "On" (upper position) the meter scale lamps should light.

METER: Moving coil meter with mirrored back to avoid parallax errors, accepting interchangeable scales for sound, vibration and voltage measurements. At the bottom of the scale a row of LEDs (Light Emitting Diodes) indicate which particular measurement range is selected with the INPUT SECTION GAIN and OUTPUT SECTION GAIN switches of the instrument.

INPUT SECTION GAIN: Nine position switch for selection of input section gain in accurate 10 dB steps. The particular gain setting (dB re 1 V) selected is indicated by one of the INPUT SECTION GAIN LEDs to the right of the switch being lit. Overload of the input section by input signals of too high a peak level will cause the lit LED to flash, warning that the INPUT SECTION GAIN switch must be stepped clockwise to a higher voltage setting.

Note: When calibrated as in section 3.4.1, the product of the "mV" or "V" value and the "Voltage Multiplier" value printed below the lit INPUT SECTION GAIN and OUTPUT SECTION GAIN LEDs, gives the input voltage for full scale deflection on the meter.

INPUT GAIN: Single turn potentiometer with click-stop "Cal." position. Facilitates continuous adjustment of input gain (up to + 10 dB or more) between the fixed settings available with the INPUT SECTION GAIN switch.

UNCAL: LED which when lit warns that the input gain and measurement range is greater than that indicated by the INPUT SECTION GAIN and METER RANGE LEDs, due to the INPUT GAIN knob not being set to its click stop "Cal." position.

OUTPUT SECTION GAIN: Six position switch for selection of output section gain in accurate 10 dB steps. The particular gain setting selected is indicated by one of the OUTPUT SECTION GAIN LEDs to the right of the switch being lit. Overload of the output section will cause the lit LED to flash, warning that the OUTPUT SECTION GAIN switch must be stepped clockwise to a lower setting.

Note: When calibrated as in section 3.4.1, the overall gain of the 2610 from its DIRECT INPUT to its AC OUTPUT (1 V FSD), is the sum of the dB values printed above the lit INPUT SECTION GAIN and OUTPUT SECTION GAIN LEDs. See Table 5.1.

DIRECT INPUT: AC coupled input for application of the signal to be measured via a standard B & K Coaxial Plug JP 0101 (provided) or BNC Adaptor JP 0144. Has an input impedance of 1 MΩ//70 pF and maximum input voltage rating 42 V RMS in accordance with IEC 348. A GROUND socket is situated to the left of the DIRECT INPUT socket. See Grounding Considerations, section 3.1.4.

PREAMP. INPUT: 7 pin socket for connection of B & K Microphones via an associated Microphone Preamplifier fitted with standard B & K 7 pin Preamplifier Plug JP 0701 provided. In addition to a signal input it also provides the necessary voltages for operation of microphone preamplifiers and condenser microphones. For connections see Fig.2.2.

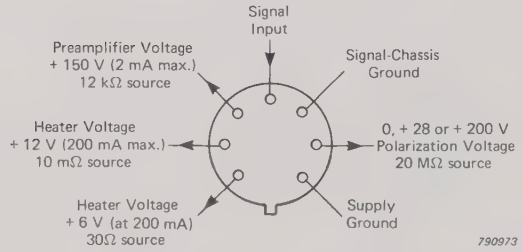

Signal Input
Preamplifier Voltage + 150 V (2 mA max.) 12 kΩ source
Signal-Chassis Ground
Heater Voltage + 12 V (200 mA max.) 10 mΩ source
0, + 28 or + 200 V Polarization Voltage 20 MΩ source
Heater Voltage + 6 V (at 200 mA) 30Ω source
Supply Ground
790973

Fig.2.2. PREAMP. INPUT socket (external view)

POL. VOLT: Three position switch for selecting microphone polarization voltage available at the PREAMP. INPUT socket. The „0 V" setting is for prepolarized microphones, whilst the + "28 V" and + "200 V" settings are for condenser microphones.

Note: Always select the required POL. VOLT setting before applying power to the 2610. If not, the time constant of the Microphone Preamplifier's polarization circuit will take approximately 10 minutes to settle to the correct voltage level when a lower POL. VOLT setting is selected.

SENS: Two single turn screwdriver operated potentiometers for independent adjustment of input section gain with the DIRECT and PREAMP. INPUTS of the 2610. They have an adjustment range from approximately

—5 to + 5 dB and are used to compensate for different transducer sensitivities.

INPUT: Two position paddle switch for selection of "Direct" and "Preamp." input.

REF: Two position paddle switch for connection of stabilized, 50 mV, 1 kHz sine wave signal to the "Direct" or "Preamp." input selected with the INPUT switch. Is used for calibration of the 2610 and of associated magnetic tape and graphic recording equipment which may be connected.

AC OUTPUT (1 V FSD): AC coupled output accepting the standard B & K Coaxial Plug JP 0101 provided, or a BNC Adaptor JP 0144. It produces an amplified version of the input signal for application to magnetic tape and graphic recording equipment. It has an output impedance of approximately 100 Ω, but for maximum output of 10 V peak with 1 V corresponding to full scale meter deflection, it should not be loaded by less than 10 kΩ or greater than 200 pF.

DETECTOR: Group of three, two position, paddle switches for selection of the following METER (and DC OUTPUT) functions:

"Peak" — "Normal". Meter indicates the maximum peak level (positive or negative, whichever is the greatest) of the applied signal. Rise and decay time 1,7 dB/μs and 40 dB/s respectively.

"Peak" — "Hold". Meter indicates and holds the maximum peak level of the applied signal. Rise and decay time 1,7 dB/μs and < 0,2 dB/minute respectively.

"RMS" — "Normal". Meter indicates the true RMS level of signals with crest factors up to 10 at full scale (up to 20 for lesser deflections). "Fast" and "Slow" time weighting in accordance with Type 0 requirements of IEC R 651, plus 20 s averaging time may be selected with the AVERAGING TIME switch.

"RMS" — "Hold". Meter indicates and holds the maximum true RMS level of the applied signal. Decay time < 0,2 dB/minute.

"Reset". Resets meter indication to zero with 0,3 s delay before meter indicates RMS or Peak level of applied signal.

AVERAGING TIME: Three position switch for selection of the following time weighting characteristics with the METER (and DC OUTPUT) when the "RMS" — "Normal" or "RMS" — "Hold" modes of the DETECTOR switches are used.

"Fast" and "Slow". In accordance with IEC R 651 for precision sound level meters (Type 0) giving effective averaging times of 250 ms and 2 s respectively. "Slow" is useful for obtaining a reasonably steady meter indication with fluctuating signal levels.

"20 s" effective averaging time. For obtaining a steady meter indication with fluctuating signal levels especially when narrow band external filters are employed with the 2610.

The particular time weighting setting selected is indicated by one of the LEDs to the left of the AVERAGING TIME switch. This indication is extinguished when the "Peak" or "Reset" mode of the DETECTOR switches is selected.

FILTERS:

A group of three, two position, paddle switches for connection of internal and external filters between the input and output section amplifiers of the 2610. Functions available are:

"Ext." — **"On"** selects operation with an external filter when this is connected to the EXTERNAL FILTER sockets on the rear panel of the 2610.

"22,4 Hz" — **"On"** selects internal high pass filter with —3 dB cut off frequency of 22,4 Hz and low frequency attenuation slope of 18 dB/octave (60 dB/decade). Helps reduce influence of unwanted low frequency environmental disturbances on measurements.

"A" — **"On"** selects internal "A" weighting network in accordance with IEC R 651 for precision sound level meters (Type 0). Helps provide indication of the subjective effects of measured sound levels.

Using the FILTER switches either one or both of the internal filters may be selected for connection in series with an external filter. When all three FILTER switches are set to **"Off"** the frequency response of the 2610 is linear to within ± 0,5 dB from 2 Hz up to 200 kHz.

2.2. REAR PANEL

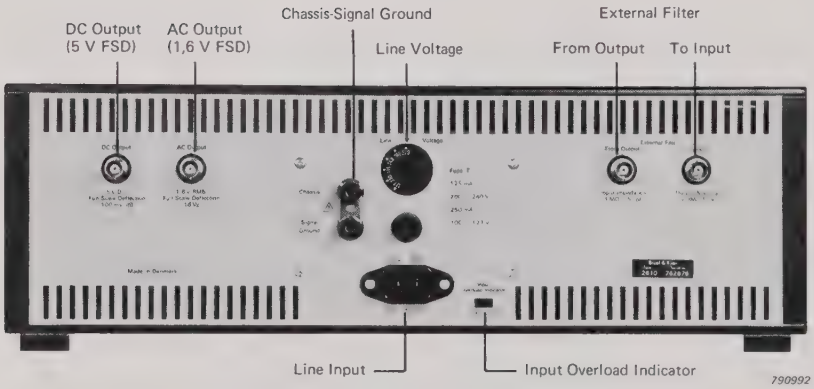


Fig.2.3. Rear panel of the 2610 Measuring Amplifier

DC OUTPUT (5 V FSD):

DC coupled output, accepting the BNC plug (B & K no. JP 0035) provided, for connection of graphic recording instrumentation. It provides a rectified and averaged DC output of 100 mV/dB proportional to the meter deflection. It has an output impedance of approximately 50 Ω, but for maximum output of 7 V (10 mA) with 5 V corresponding to full scale meter deflection, it should not be loaded by less than 0,7 kΩ.

AC OUTPUT (1,6 V FSD):

AC coupled output accepting the BNC plug (B & K no. JP 0035) provided. It produces an amplified version of the input signal for applica-

tion to magnetic tape and graphic recording equipment. It has an output impedance of approximately 50 Ω, but for maximum output of 16 V peak with 1,6 V RMS corresponding to full scale meter deflection, it should not be loaded by less than 10 kΩ or greater than 200 pF.

EXTERNAL FILTER: Two coaxial sockets accepting the BNC plugs (B & K no. JP 0035) provided for connection of an external filter to the 2610. The FROM (EXT. FILTER) OUTPUT socket has an input impedance of 1 MΩ//50 pF and maximum input voltage rating of 10 V peak, while the TO (EXT. FILTER) INPUT socket produces a maximum output of 10 V peak with 1 V RMS corresponding to full scale meter deflection. The input impedance of the external filter should be 5 kΩ//200 pF or greater.

INPUT OVERLOAD INDICATOR: Two position switch for selection of the input section overload detector trigger level to suit the maximum input voltage requirements of different external filters. The levels of "5 V pk" and "10 V pk" marked on the switch, are referred to the TO (EXT. FILTER) INPUT socket of the 2610 and are equivalent to 5 and 10 times full scale deflection on the meter.

LINE VOLTAGE: Six position switch for selection of correct mains voltage setting as described in section 3.1.3.

FUSE: Fuse holder, accepting a 125 mA slow blow fuse (B & K no. VF 0030) for 200 to 240 V mains supplies or 250 mA slow blow fuse (B & K no. VF 0031) for 100 to 127 V mains supplies. To check and fit the appropriate fuse, see section 3.1.3.

LINE INPUT: Two pin socket accepting the Power Cable AN 0020 provided for connection of a 100, 115, 127, 200, 220 or 240 V ± 10% (50 to 400 Hz) AC mains supply. Before connecting a supply, the mains voltage setting and fuse checks given in section 3.1.3 should be carried out.

CHASSIS-SIGNAL GROUND: A pair of clamping terminals and metal bus for connection of signal ground to chassis of the 2610. See Grounding Considerations section 3.1.4.

⚠ **WARNING:** The 2610 is designed to be operated with its signal ground lines and chassis always at earth potential. Never let the signal ground terminal, socket screens or chassis float at any other potential, as this will impair the operating safety of the 2610 and may damage the instrument.

3. OPERATION

3.1. PRELIMINARY

3.1.1. Environment and Handling

Measuring Amplifier Type 2610 is a robust instrument which is designed to be operated in environments with temperature from + 5 to + 40°C (+ 41 to + 104°F) and humidities up to 90% RH (non condensing). Other than ensuring proper connection of the mains supply and replacement of meter scales with power set to off, no special handling precautions are necessary.

3.1.2. Mounting

The 2610 may be used free standing on its four plastic feet or, for easier viewing, its front may be raised by folding down the flanges attached to its front feet. For better grip on smooth surfaces, the feet may be fitted with the rubber inserts DF 7033 provided.

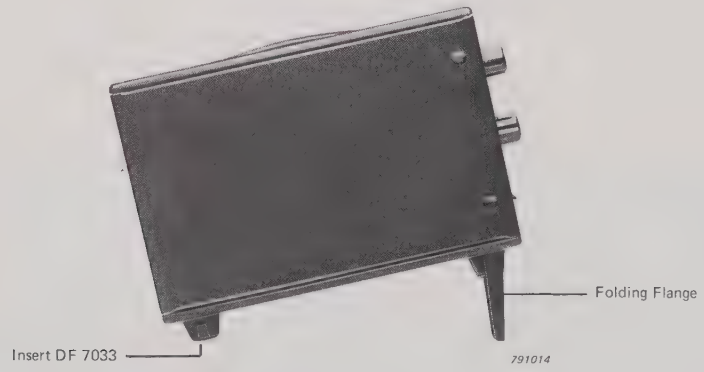


Fig.3.1. The 2610 with its front panel raised and its feet fitted with rubber inserts DF 7033

Optional types of mounting for use with the 2610 are a Mahogany Case KA 0027 for protection of the instrument during transportation and isolation Flanges KS 0038 for mounting it in a 19-inch instrumentation rack. For fastening the flanges, two screw holes hidden by removable plastic caps, are provided at the front of each of the instrument's side panels.

3.1.3. Connection of Mains Supply

Before connecting a mains supply the following checks and adjustments should be carried out to ensure safe operation of the instrument.

Mains Voltage Setting

The 2610 may be powered from 100, 115, 127, 200, 220 and 240 V ± 10% (50 to 400 Hz) single phase AC mains lines. To select the correct mains voltage setting, use a small coin or wide blade screwdriver to turn the LINE VOLTAGE selector on the rear panel so that the appropriate voltage setting on the selector lines up with the black arrow printed on the panel.

Fuse Rating

The mains fuse is contained in the fuse holder immediately below the LINE VOLTAGE selector. It may be released using a screwdriver to turn the centre of the holder. For operation from 100 to 127 V supplies the fuse should be a 250 mA slow blow (B & K no. VF 0031) whilst for 200 to 240 V supplies it should be a 125 mA slow blow (B & K no. VF 0030). Make sure that only fuses of the required rated current and of specified type are used for replacement. The use of mended fuses or the short circuiting of fuse holders is prohibited.

Mains Socket Connections

Once the mains setting and fuse have been checked, the mains supply may be connected to the LINE INPUT socket of the apparatus using the Power Cable AN 0020 provided. The 2610 has a high standard of safety insulation and therefore its chassis need not be connected to mains ground.

3.1.4. Grounding Considerations

Indiscriminate grounding of instruments can introduce ground loop interference. To prevent this it is necessary to ensure that the signal ground line of the 2610 and of other instruments with which it is used is grounded at one point only in the measurement system. To do this without prejudicing the operating safety of the measurement system, proceed as follows:

1. Connect the signal ground lines of all instruments together. This is done automatically through the screens of the input and output cables used to interconnect the instruments.

2. If instruments equipped with a mains socket chassis terminal are employed in the measurement arrangement then check that a) one and only one of these instruments has its signal ground line connected via chassis to mains ground and b) the housing of the measurement transducer is isolated from grounded measurement sources.

3. If the measurement arrangement is used free standing without the instrument cabinets touching, then ensure that each of the other instruments in the measurement arrangement has its chassis connected to a) mains ground only or b) signal ground only. With instruments having a mains socket chassis terminal, a) is to be preferred.

4. If the measurement arrangement is mounted in a metal instrumentation rack, then ensure that one and only one of the instruments has its signal ground line connected to chassis (and chassis connected to mains ground if equipped with mains socket chassis terminal). If more than one of the instruments has a permanent signal ground chassis connection, then isolate the cabinets of these instruments from the rack using isolating flanges for mounting.

To disconnect the signal ground line of the 2610 from its chassis, as might be necessary to conform with the above grounding requirements, unscrew the CHASSIS and SIGNAL GROUND terminal clamps on the rear panel and lift up, and clamp, the connection bus to the CHASSIS terminal. For stand-alone use of the 2610 without other instruments connected, always keep the CHASSIS and SIGNAL GROUND terminals connected by the bus.

⚠ **WARNING:** The 2610 is designed to be operated with its signal ground line and chassis always at earth potential. Never let the signal ground terminal, socket screens or chassis float at any other potential as this will impair the operating safety of the 2610 and may damage the instrument.

3.2. SOUND MEASUREMENTS

For sound measurements, the 2610 may be calibrated using the internal reference voltage provided. However, if a more precise calibration is required which takes into account the actual sensitivity of the particular Microphone and Microphone Preamplifier employed, then a Pistonphone Type 4220 or a Sound Level Calibrator Type 4230 should be used. The Pistonphone may be directly coupled to any Microphone in the B & K range and produces a nominal sound pressure level of 124 dB re 20 μPa* at 250 Hz. It has an accuracy of ± 0,2 dB.

The Sound Level Calibrator fits one and half-inch B & K Microphones and produces a nominal sound pressure level of 94 dB re. 20 μPa* at 1 kHz. Its calibration accuracy is ± 0,25 dB.

3.2.1. Calibration using Pistonphone Type 4220 or Sound Level Calibrator Type 4230

1. Carry out the preliminary adjustments necessary (see section 3.1) and wait until item 4 before selecting POWER "On".

2. Fit the microphone and associated preamplifier to the PREAMP. INPUT socket of the 2610. See B & K Short or Main Catalogue for suitable types of microphone and preamplifier. For use as a Type 0 precision sound level meter in accordance with IEC R 651, the 2610 should be used with a B & K 1/2-inch Condenser Microphone Type 4133, 4148 or 4165.

3. Fit the 2610 with a meter scale appropriate to the sensitivity of the particular microphone employed. See Table 3.1.

Scale	Microphone Sensitivity
SA 0252	28 to 89 mV/Pa
SA 0253	5 to 16 mV/Pa
SA 0241*	1,6 to 5 mV/Pa
SA 0242*	0,5 to 1,6 mV/Pa

*Accessory available 800156

Table 3.1. Meter scales for sound measurements with the 2610

* For the exact sound pressure, see the Pistonphone or Sound Level Calibrator calibration chart. 1 Pa = 10 μbar

To fit the appropriate scale, push down and pull forward the central clip on top of the meter and with the meter pulled forward, lift the clip to slide out the scale to be replaced. Fit the clip to the required scale and insert it in the meter, taking care not to damage the meter pointer.

4. Set control switches and knobs on the 2610 as follows:

INPUT:	"Preamp."
POL. VOLT:	as required for particular microphone employed. See microphone calibration chart and POL. VOLT. in section 2.1
REF:	"Off"
INPUT GAIN:	click-stop "Cal." position
INPUT SECTION GAIN:	extreme clockwise position
OUTPUT SECTION GAIN:	extreme clockwise position
FILTERS:	"Linear 2 Hz to 200000 Hz" i.e. all three FILTER switches set to "Off"
DETECTOR:	"RMS" — "Normal"
AVERAGING TIME:	"Fast" i.e. extreme anticlockwise position
POWER:	"On"

5. Step the INPUT SECTION GAIN knob anticlockwise until a "100 dB" for Pistonphone calibration or "70 dB" for Sound Level Calibrator calibration is indicated as the zero level on the meter scale by the meter range LEDs.

6. Fit the Pistonphone or Sound Level Calibrator with an adaptor appropriate for the size of the microphone employed and momentarily press the push-button on the side of its housing to start its reference tone. If the reference tone lasts only a few seconds after having released the push-button, then the internal battery should be replaced.

7. Fit the Pistonphone or Sound Level Calibrator so that it fits snuggly over the front microphone and press the push button to start the reference tone.

8. Using the small screwdriver provided, adjust the SENS. ADJ. potentiometer for the PREAMP. INPUT of the 2610 so that the meter indicates a sound pressure level of 124 dB* with the Pistonphone or 94 dB** with the Sound Level Calibrator. The indicated sound pressure level is the meter pointer indication in dB plus the dB value indicated by the lit meter range LED.

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* For the exact sound pressure, the Pistonphone Calibration Chart should be consulted

** For the Sound Level Calibrator, the SPL indication should be 94 dB for a pressure response microphone, 93,6 dB for a 1-inch free field microphone, or 93,9 dB for a 1/2-inch free field microphone. See also 4230 Instruction Manual

9. Once correctly adjusted, remove the Pistonphone or Sound Level Calibrator, and turn the INPUT SECTION GAIN knob to its extreme clockwise position ready for measurements.

3.2.2. Calibration using the Internal Reference Voltage

1. Carry out the preliminary adjustments necessary (see section 3.1) and wait until item 4 before selecting POWER "On".

2. Fit the microphone and associated preamplifier to PREAMP. INPUT socket of the 2610. See B & K Short or Main Catalogues for suitable types of microphone and preamplifier. For use as a Type 0 precision sound level meter in accordance with IEC R 651, the 2610 should be used with a B & K 1/2-inch Condenser Microphone Type 4133, 4148, 4165.

3. Fit the 2610 with a meter scale appropriate to the sensitivity of the particular microphone employed. See Table 3.1.

   To fit the appropriate scale, push down and pull forward the central clip on top of the meter and with the meter pulled forward, lift the clip to slide out the scale to be replaced. Fit the clip to the required scale and insert it in the meter, taking care not to damage the meter pointer.

4. Set control switches and knobs on the 2610 as follows:

INPUT:	"Preamp."
POL. VOLT:	as required for particular microphone employed. See microphone calibration chart and POL. VOLT. in section 2.1
REF:	"50 mV RMS"
INPUT GAIN:	click-stop "Cal." position
INPUT SECTION GAIN:	extreme clockwise setting
OUTPUT SECTION GAIN:	extreme clockwise setting
FILTERS:	"Linear 2 to 200000 Hz" i.e. all three FILTER switches set to "Off"
DETECTOR:	"RMS" — "Normal"
AVERAGING TIME:	"Fast" i.e. extreme anticlockwise position
POWER:	"On"

5. From the calibration chart of the microphone in use, determine the Open Circuit Correction Factor K_o of the microphone and subtract the gain of the preamplifier (see back of microphone calibration chart) to obtain the actual correction factor for the microphone and preamplifier combination. For example with 1/2 inch microphone having an Open Circuit Correction Factor $K_o = +13$ dB and preamplifier having a gain of —0,4 dB, the actual K Factor = + 13 — (—0,4) dB = 13,4 dB.

6. Step the INPUT SECTION GAIN knob anticlockwise until the "20 dB" — "100 mV" INPUT SECTION GAIN LED lights and using the small screwdriver provided, adjust the SENS. ADJ. potentiometer for the PREAMP. INPUT to move the meter pointer to the required K Factor on the "K Factor" scale of the meter.

7. Once correctly adjusted, set the REF. switch to "Off" and the INPUT SECTION GAIN knob to its extreme clockwise position, ready for measurements.

3.2.3. Sound Measurement Procedure

1. Calibrate the 2610 for sound, by one of the methods described in section 3.2.1 or 3.2.2.

2. Using the FILTER switches select the appropriate linear frequency response or A-weighting mode for measurements. If external filters are to be used, then these may be connected to the EXTERNAL FILTER sockets on the rear panel, after the "Ext." FILTER switch has been set to "On".

3. Hold the microphone steady and at least 1 m away from the body, or set it up on a tripod or other support that will not interfere with the sound field.

4. Keeping the OUTPUT SECTION GAIN knob in its extreme clockwise position, step the INPUT SECTION GAIN knob anticlockwise until a suitable meter indication is obtained.

   If the INPUT SECTION GAIN LED starts to flash warning of overload, then step the INPUT SECTION GAIN knob clockwise to a higher measurement range which does not produce an overload indication. If the meter pointer remains at full scale then momentarily set the left-hand DETECTOR switch to its "Reset" position.

   If the meter indication is insufficient, even when the INPUT SECTION GAIN knob is set to its extreme anticlockwise position, then step the OUTPUT SECTION GAIN knob anticlockwise until a suitable indication without overload is obtained.

   To obtain a steady meter indication with fluctuating sound levels, set the AVERAGING TIME knob to its "Slow" position.

5. The measured sound level or sound pressure level is the meter pointer indication in dB, plus the dB value indicated by the lit meter range LED.

In reporting sound levels it should always be stated which filter or weighting network has been used e.g. 60 dB(A). The maximum sound pressure levels which can be measured accurately with 1/2 and 1-inch microphones with respect to the crest factor of the signal can be seen in Fig.3.2. For detailed information on sound measurement theory and practice, the B & K "Acoustic Noise Measurements" book should be consulted.

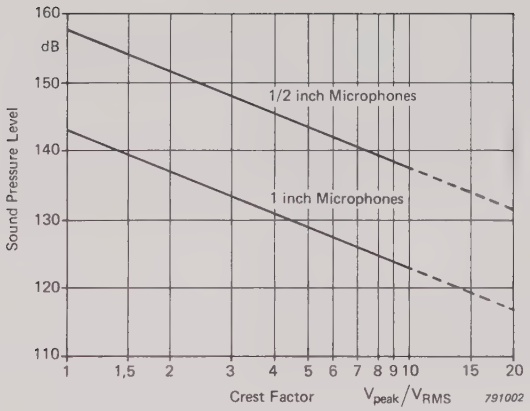


Fig.3.2. Maximum sound pressure levels for B & K 1/2 and 1-inch Condenser Microphones

3.3. VIBRATION MEASUREMENTS

For vibration measurements, calibration depends on the particular accelerometer and vibration preamplifier employed. If one of the B & K Conditioning Amplifiers Types 2626, 2635 or 2650 is chosen, then the 2610 should be calibrated as in section 3.4.1 and measurements carried out as described in the Instruction Manual for the particular Conditioning Amplifier. With these amplifiers, sensitivity conditioning networks permit direct dial-in of exact transducer sensitivity enabling unified system sensitivities to be selected for all types of B & K piezoelectric accelerometer, including those with "odd" sensitivity values.

With other types of vibration preamplifier, calibration and measurement are as described in the following sections. For measurements using fixed or variable sensitivity preamplifiers the use of the Accelerometer Calibrator Type 4291 is recommended for calibration. This produces a reference vibration level of $10\,ms^{-2}$ which enables the measurement system to be accurately adjusted for use with all types piezoelectric accelerometer, whatever their sensitivity. Alternatively, with fixed sensitivity preamplifier — Uni-Gain® accelerometer combinations, the internal reference voltage of the 2610 may be used for calibration.

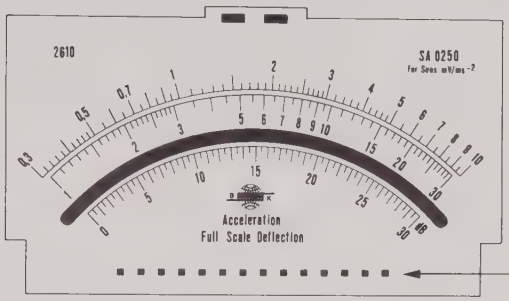
3.3.1. Calibration using Accelerometer Calibrator Type 4291

1. Carry out the preliminary adjustments necessary (see section 3.1) and wait until item 4 before selecting POWER "On".

2. Graduate the range indication holes of vibration scale SA 0250 with the measurement ranges appropriate for the nominal overall sensitivity of the particular accelerometer and vibration preamplifier to be used for measurements. See Table 3.2.

3. Fit the 2610 with vibration scale SA 0250. To do this, push down and pull forward the central clip on top of the meter and with the meter pulled forward, lift the clip to slide out the scale to be replaced. Fit the clip to scale SA 0250 and insert it in the meter, taking care not to damage the meter pointer.

4. Set control switches and knobs on the 2610 as follows:

Overall Accelerometer and Preamplifier Sensitivity		
Nominal	Adjustment Range	Vibration Scale SA 0250 — Measurement Ranges
1000* mV/ms^{-2}	560 to 1750 mV/ms^{-2}	μms^{-2}: 10 30 100 300 · mms^{-2}: 1 3 10 30 100 300 · ms^{-2}: 1 3 10 30
300 mV/ms^{-2}	175 to 530 mV/ms^{-2}	μms^{-2}: 30 100 300 · mms^{-2}: 1 3 10 30 100 300 · ms^{-2}: 1 3 10 30 100
100* mV/ms^{-2}	56 to 175 mV/ms^{-2}	μms^{-2}: 100 300 · mms^{-2}: 1 3 10 30 100 300 · ms^{-2}: 1 3 10 30 100 300
30 mV/ms^{-2}	17,5 to 53 mV/ms^{-2}	μms^{-2}: 300 · mms^{-2}: 1 3 10 30 100 300 · ms^{-2}: 1 3 10 30 100 300 · kms^{-2}: 1
10* mV/ms^{-2}	5,6 to 17,5 mV/ms^{-2}	mms^{-2}: 1 3 10 30 100 300 · ms^{-2}: 1 3 10 30 100 300 · kms^{-2}: 1 3
3 mV/ms^{-2}	1,75 to 5,3 mV/ms^{-2}	mms^{-2}: 3 10 30 100 300 · ms^{-2}: 1 3 10 30 100 300 · kms^{-2}: 1 3 10
1* mV/ms^{-2}	0,56 to 1,75 mV/ms^{-2}	mms^{-2}: 10 30 100 300 · ms^{-2}: 1 3 10 30 100 300 · kms^{-2}: 1 3 10 30
0,3 mV/ms^{-2}	0,175 to 0,53 mV/ms^{-2}	mms^{-2}: 30 100 300 · ms^{-2}: 1 3 10 30 100 300 · kms^{-2}: 1 3 10 30 100
0,1* mV/ms^{-2}	0,056 to 0,175 mV/ms^{-2}	mms^{-2}: 100 300 · ms^{-2}: 1 3 10 30 100 300 · kms^{-2}: 1 3 10 30 100 300
0,03 mV/ms^{-2}	0,0175 to 0,053 mV/ms^{-2}	mms^{-2}: 300 · ms^{-2}: 1 3 10 30 100 300 · kms^{-2}: 1 3 10 30 100 300 1000

* Unified Sensitivity

Table 3.2. Meter range LED graduations with vibration scale SA 0250. 1 g = 9,81 ms^{-2}

INPUT:	as required for particular vibration preamplifier used
POL. VOLT:	"0 V"
REF:	"Off"
INPUT GAIN:	click-stop "Cal." position
INPUT SECTION GAIN:	extreme clockwise position
OUTPUT SECTION GAIN:	extreme clockwise position
FILTERS:	"Linear 2 to 200000 Hz" i.e. set all three FILTER switches to "Off"
DETECTOR:	"Peak" — "Normal"
AVERAGING TIME:	not relevant for peak mode
POWER:	"On"

5. Mount the accelerometer on the vibration table of the Accelerometer Calibrator Type 4291 and set the FUNCTION SELECTOR of the instrument to its "Batt. Check" mode. If the meter pointer of the instrument lies outside the "Battery" range of the meter then the internal batteries should be replaced.

6. Connect the accelerometer and preamplifier combination to the appropriate INPUT on the 2610 and set the power switch of the preamplifier to "On".

7. Using the 4291 vibrate the accelerometer at 10 ms^{-2}, peak and step the INPUT SECTION GAIN knob of the 2610 until the 10 ms^{-2} meter range LED lights.

8. Switch or adjust the sensitivity of the Preamplifier to obtain an on-scale meter indication and using the small screwdriver provided turn the SENS. ADJ. potentiometer of the appropriate INPUT on the 2610, until the meter indicates an acceleration level of 10 ms^{-2} on the 0,3 to 10 range of the scale.

9. Once correctly adjusted, remove the accelerometer from the Accelerometer Calibrator and set the INPUT SECTION GAIN knob of the 2610 to its extreme clockwise position, ready for measurements.

3.3.2. Calibration using Internal Reference Voltage

1. Carry out the preliminary adjustments necessary (see section 3.1) and wait until item 5 before selecting POWER "On".

2. Select an accelerometer and vibration preamplifier combination having a unified overall sensitivity of 1, 10, 100 or 1000 mV/ms^{-2} and connect to the appropriate INPUT of the 2610.

3. Graduate the range indication holes of vibration scale SA 0250 with the measurement ranges appropriate for the overall sensitivity of the accelerometer and preamplifier. See Table 3.2.

4. Fit the 2610 with vibration scale SA 0250. To do this, push down and pull forward the central clip on top of the meter and with the meter pulled forward, lift the clip to

slide out the scale to be replaced. Fit the clip to scale SA 0250 and insert in the meter, taking care not to damage the meter pointer.

5. Set control switches and knobs on the 2610 as follows:

INPUT:	as appropriate for vibration preamplifier connected
POL. VOLT:	"0 V"
REF:	"50 mV RMS"
INPUT GAIN:	click-stop "Cal." position
INPUT SECTION GAIN:	extreme clockwise position
OUTPUT SECTION GAIN:	extreme clockwise position
FILTERS:	"Linear 2 to 200000 Hz" i.e. set all three FILTER switches to "Off"
DETECTOR:	"RMS" — "Normal"
AVERAGING TIME:	"Fast" i.e. extreme anticlockwise position
POWER:	"On"

6. Step the INPUT SECTION GAIN knob anticlockwise until the "20 dB" — "100 mV" INPUT SECTION GAIN LED lights and using the small screwdriver provided, turn the SENS. ADJ. potentiometer of the appropriate INPUT on the 2610 to obtain a reference indication of 5 on the 0,3 to 10 range of the meter scale.

7. Once correctly adjusted, set the REF. switch to "Off" and step the INPUT SECTION GAIN knob to its extreme clockwise position, ready for measurements.

3.3.3. Vibration Measurement Procedure

1. Calibrate the 2610 by one of the methods described in section 3.3.1 and 3.3.2.

2. Using the DETECTOR switches, select the appropriate RMS or Peak indicating mode for measurements. If RMS measurements are to be made, then also select the appropriate "Fast" or "Slow" meter damping characteristic using the AVERAGING TIME knob.

3. Using the FILTER switches, select the appropriate linear frequency response mode for measurements. Do not select "A" weighting as this is for sound measurements only. If external filters are to be used, then these may be connected to the EXTERNAL FILTER sockets on the rear panel, after the "Ext." FILTER switch has been set to "On".

4. On the vibration preamplifier, select an upper limiting frequency that excludes the accelerometer mounted resonance frequency from the measurement. Alternatively, use a Mechanical Filter UA 0559 for mounting the accelerometer on the measurement object.

5. Mount the accelerometer as rigidly as possible onto the measurement object, taking care to avoid cable whip. See B & K "Piezoelectric Accelerometer and Vibration Preamplifier" handbook for details of approved mounting techniques.

6. Start vibration of the measurement object and step the INPUT SECTION GAIN knob anticlockwise to obtain a suitable meter indication.

7. If the INPUT SECTION GAIN LED starts to flash warning of overload, then step the INPUT SECTION GAIN knob clockwise to a higher measurement range which does not produce an overload indication. If the meter pointer remains at full scale then momentarily set the left-hand DETECTOR switch to its "Reset" position.

8. If the meter indication is insufficient, even when the INPUT SECTION GAIN knob is set to its extreme anticlockwise position, then step the OUTPUT SECTION GAIN knob anticlockwise to obtain a suitable meter indication without overload.

9. The acceleration level of the measured vibration can be read directly from the meter where the acceleration level for full scale deflection is indicated by the lit range LED at the bottom of the meter.

For detailed information on vibration measurement theory and practice, the B & K "Mechanical Vibration and Shock Measurements" book should be consulted.

3.4. VOLTAGE MEASUREMENTS

For voltage measurements, the DIRECT INPUT of the 2610 is used. This accepts the standard B & K Coaxial Plug JP 0101 provided or a BNC Adaptor JP 0144 and 10:1 Input Probe ZC 0016 which can be obtained as an accessory. It has an input impedance of 1 MΩ in parallel with 70 pF and can tolerate input voltages up to 220 V RMS (400 V Peak including DC component) at frequencies up to 60 Hz without damaging the instrument. However for measurement of voltage levels in excess of 30 V RMS or Peak it should be connected with the 10:1 Input Probe which has on input impedance of 10 MΩ in parallel with approximately 12 pF and can tolerate voltages up to 350 V RMS (500 V Peak including DC component) at frequencies up to 200 kHz.

3.4.1. Calibration

1. Carry out the preliminary adjustments necessary, (see section 3.1) and wait until item 3 before selecting POWER "On".

2. Fit the 2610 with voltage scale SA 0238. To do this, push down and pull forward the central clip on top of the meter and with the meter pulled forward, lift the clip to slide out the scale to be replaced. Fit the clip to scale SA 0238 and insert in the meter, taking care not to damage the meter pointer.

3. Set control switches and knobs on the 2610 as follows:

INPUT:	"Direct"
REF:	"50 mV RMS"
INPUT GAIN:	click-stop "Cal." position
INPUT SECTION GAIN:	extreme clockwise position
OUTPUT SECTION GAIN:	extreme clockwise position
FILTERS:	"Linear 2 to 200000 Hz" i.e. set all three FILTER switches to "Off"

DETECTOR:	"RMS" — "Normal"
AVERAGING TIME:	"Fast" i.e. extreme anticlockwise position
POWER:	"On"

4. Step the INPUT SECTION GAIN knob anticlockwise until the "20 dB" — "100 mV" meter range LED lights and using the small screwdriver provided turn the SENS. ADJ. potentiometer for the DIRECT INPUT to obtain a reference indication of 5 (i.e. 50 mV) on the 0,3 to 10 range of the meter.

5. Once correctly adjusted, set the REF. switch to "Off" and step the INPUT SECTION GAIN knob to its extreme clockwise position ready for measurements.

3.4.2. Calibration including 10 : 1 Input Probe ZC 0016

The Input Probe ZC 0016 is calibrated at B & K and therefore when first used with the 2610 need not be recalibrated. However with subsequent use of the probe it is recommended that the following calibration procedure is applied to check that the probe has not been misadjusted or damaged during previous use.

1. Calibrate the 2610 for voltage measurements as described in section 3.4.1 and connect its DIRECT INPUT directly to the sine output of a signal generator such as B & K Type 1023 or 1027.

2. Set the generator output frequency to 20 Hz and adjust its output level as well as the INPUT SECTION GAIN knob of the 2610 to obtain a meter deflection of exactly 6 dB below full scale on the Measuring Amplifier. Do not readjust the Generator output level as it will prevent accurate calibration.

3. Disconnect the DIRECT INPUT from the output of the generator and reconnect using the BNC Adaptor JP 0144 and 10 : 1 Input Probe ZC 0016. Ensure that the signal

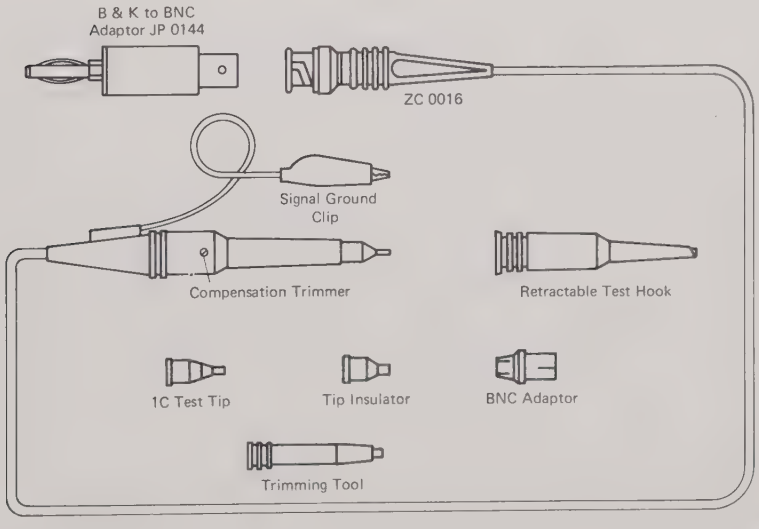


Fig.3.3. B & K to BNC Adaptor JP 0144, plus 10 : 1 Input Probe ZC 0016 and range of accessories with which it is supplied

ground clip of the probe is attached to the ground socket or output socket screen of the generator.

4. Step the INPUT SECTION GAIN knob two positions anticlockwise (i.e. increase input sensitivity by a factor of 10 e.g. 20 dB) and check that the meter deflection settles at exactly 6 dB below full scale as in item 2. If not, adjust the DIRECT INPUT SENS. ADJ. potentiometer of the 2610 until the correct meter deflection is obtained.

5. Increase the output frequency of the generator and check that the meter deflection remains at 6 dB below full scale at frequencies up to 200 kHz (or 20 kHz, if 200 kHz is not available). If not use the small black trimming tool provided to adjust the probe compensation trimmer (see Fig.3.3) until the correct meter deflection of 6 dB below full scale is obtained.

6. Once correctly adjusted, disconnect the Input Probe from the generator and set the INPUT SECTION GAIN knob to its extreme clockwise setting ready for measurements.

3.4.3. Voltage Measurement Procedure

1. Calibrate the 2610 as described in section 3.4.1. or 3.4.2.

2. Using the DETECTOR switches, select the appropriate "RMS" or "Peak" indicating mode for measurements. If RMS measurements are to be made, then also select the appropriate "Fast" or "Slow" meter damping characteristic using the AVERAGING TIME knob.

3. Using the FILTER switches, select the appropriate linear frequency response mode. For noise measurements on audio systems the "A" weighting mode may be used. If external filters are to be used then these may be coupled to the EXTERNAL FILTER sockets on the rear panel, after the "Ext." FILTER switch has been set to "On".

4. Apply the voltage to be measured to the DIRECT INPUT socket and step the INPUT SECTION GAIN knob anticlockwise to obtain a suitable meter indication.

5. If the INPUT SECTION GAIN LED flashes, warning of overload, then step the INPUT SECTION GAIN knob clockwise to a higher measurement range which does not produce an overload indication. If the meter pointer remains at full scale, then also momentarily set the left-hand DETECTOR switch to its "Reset" position.

6. If the meter indication is insufficient, even when the INPUT SECTION GAIN knob is set to its extreme anticlockwise setting, then step the OUTPUT SECTION GAIN knob anticlockwise to obtain a suitable meter indication without overload.

7. The measured voltage level can be read directly from the meter where the voltage level corresponding to full scale deflection is indicated by the lit range LED at the bottom of the meter. If the 10 : 1 Input Probe is connected then multiply the meter indication by a factor of 10 to obtain the measured voltage level.

3.5. REMOTE CONTROL

Mounted inside the 2610 are two fixed plugs. These are shown in Fig.3.4 and are intended for use with automatic test equipment at the B & K factory. However, with the aid of two specially made up cables and an appropriate external switching arrangement, they may be used for manually operated remote control of the instrument.

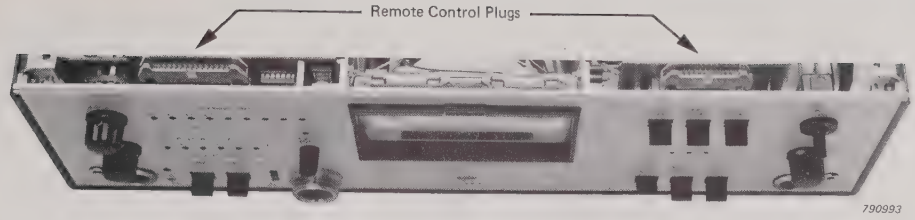


Fig.3.4. Internal plugs for remote control of the 2610

Function		Connect Pin 23 or 24 to	Connect Pin 19 or 20 to	Stand-by setting
INPUT SECTION GAIN:	"40 dB" – "10 mV"	10	–	
	"30 dB" – "30 mV"	8	–	
	"20 dB" – "100 mV"	6	–	
	"10 dB" – "300 mV"	2	–	"50 dB" "3 mV"
Priority ↓	"0 dB" – "1V"	3	–	
	"–10 dB" – "3 V"	5	–	
	"–20 dB" – "10 V"	1	–	
	"–30 dB" – "30 V"	4	–	
OUTPUT SECTION GAIN:	"40 dB" – "0,01"	17	–	
	"30 dB" – "0,03"	16	–	
	"20 dB" – "0,1"	18	–	
Priority ↓	"10 dB" – "0,3"	14	–	"50 dB" "0,003"
	"0 dB" – "1"	9	–	
INPUT:	"Direct"	–	25	"Preamp."
REF.:	"50 mV RMS"	–	21	"Off"

790685

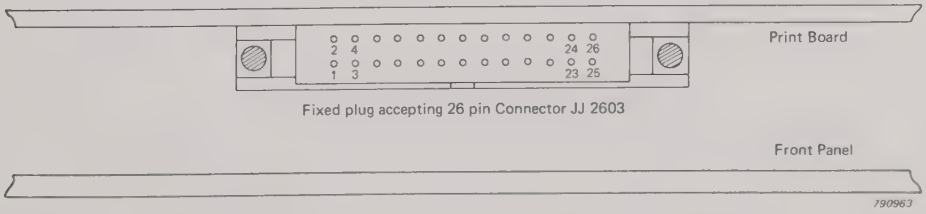
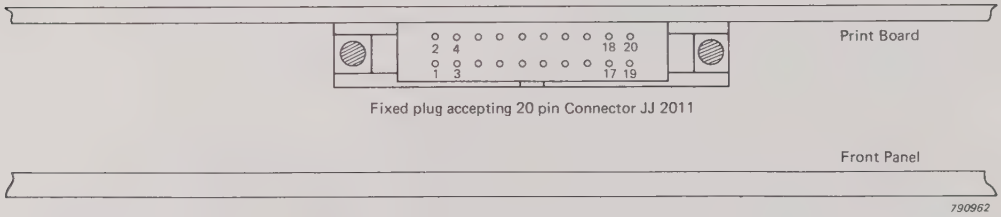


Table 3.3. Remote control lines available with internal 26 pin plug of the 2610

For access to the plugs, disconnect all mains power from the 2610, and remove the four black plastic caps and screws fastening its top panel. The plug to the left of the indicating meter accepts a 26 pin connector B & K no. JJ 2603, whilst that on the right accepts a 20 pin connector B & K no. JJ 2011. Plug pin identities are listed in Tables 3.3 and 3.4 which also give the initial stand by settings to which the various control knobs and switches on the 2610 must be set for remote operation.

Function		Connect pin 13 to	Connect pin 3 to	Stand-by setting
FILTERS:	"Ext." – "On"	15	–	"Off"
	"22,4 Hz" – "On"	17	–	"Off"
	"A" – "On"	19	–	"Off"
DETECTOR:	"Reset"	–	6	"Normal"
	"Normal"	–	8	"Hold"
	"Peak"	–	16 and 20	"RMS"
AVERAGING TIME: (For RMS function only)	"Slow"	–	14 and 20	"Fast"
	"20 s"	–	12 and 20	

790686



790962

Table 3.4. Remote control lines available with internal 20 pin plug of the 2610

As indicated in Table 3.3 and 3.4, remote control is exercised by interconnecting two or more pins on the plugs. Remote selection of INPUT and OUTPUT SECTION GAIN is best accomplished using "make before break" types of switch to interconnect the appropriate pins. This will prevent the INPUT and OUTPUT SECTION GAIN momentarily reverting to their "50 dB" stand by settings when switching from one gain setting to the next. With the other remote control functions available, the use of "break before make" types of switch are recommended. The switch rating should be 6 V, 100 mA.

⚠ **WARNING:** Disconnect all mains power from the 2610 before attempting to remove or replace its protective panels. Internal adjustments with mains power connected, should be carried out only by skilled persons who are aware of the hazards of dealing with live circuitry.

4. USE WITH OTHER INSTRUMENTS

.1. FREQUENCY ANALYSIS

For detailed investigation of sound, vibration and voltage signals, the 2610 may be used with one of the filters listed in Table 4.1. These have selectable bandwidths with centre frequency that may be manually or automatically stepped or swept along the frequency axis of the measured signal, thus enabling frequency analysis to be carried out. They may be connected to the 2610 via the EXTERNAL FILTER sockets on its rear panel and are selected for operation with or without the internal "22,4 Hz" high pass filter or "A" weighting network selected, by setting the EXT. FILTER switch of the 2610 to "On". For an overload warning which takes into account the maximum input voltage rating of these filters, the INPUT OVERLOAD INDICATOR switch on the rear panel of the 2610 should be set to "5 V pk".

For detailed information on performing frequency analyses, as well as automatic recording of analyzed spectra using a level or X-Y recorder, the Instruction Manual for the relevant filter should be consulted.

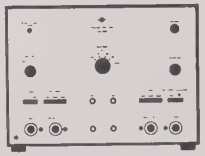
.2. GRAPHIC RECORDING

For automatic recording of measured signal levels or analyzed frequency spectra, the 2610 may be used with the Level and X-Y Recorders listed in Table 4.2. These are designed to quickly present accurate hard copy graphic plots of signal levels and frequency spectra on preprinted level and frequency graduated paper. Their clear, easy to read paper-based readout is not only ideal for storage and future reference purposes, but also aids fast onsite evaluation and comparison of results.

Depending on the particular recorder employed, recordings can be made using the signal available at either the AC OUTPUT (1,6 V FSD) or the DC OUTPUT (5 V FSD) on the rear panel of the 2610. The AC OUTPUT is for recorders having an "AC Log" record mode, whilst the DC OUTPUT is for those with a "DC Lin" mode. Generally, DC recording is to be preferred as rectification and averaging of the signal is performed by the Detectors of the 2610. Besides enabling Peak and RMS levels to be plotted on logarithmic amplitude (linear dB scale), it responds to very short duration signal peaks and for recording of RMS levels provides precise electronic averaging of the signal. With AC recording, averaging is primarily a function of the recorders writing speed and is therefore not as precise. The effective averaging times available with the "Fast", "Slow" and "20 s" AVERAGING TIME switch settings of the 2610, are 250 ms, 2 s and 20 s respectively.

Note: The use of the DC record mode of the 2307 Level Recorder with the 2610 is not recommended, as it has a fixed DC offset of approximately 5 mV. However, its AC record mode can be used with advantage, as it has an extremely wide range of writing and paper speed settings, as well as a record range of up to 75 dB.

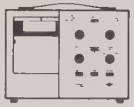
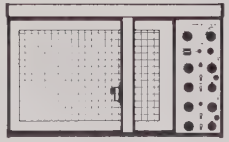
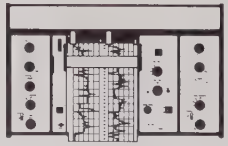
For further information on the use of the B & K Level and X-Y Recorders, their relevant Instruction Manuals should be consulted.

B & K Filter Type		1617	1618	1621	1623	 2020
Analysis Bandwidth	Constant %	Octave and Third Octave	Octave and Third Octave	3 and 23%	6; 12 and 23%	–
	Constant Bandwidth	–	–	–	–	3,16; 10; 31,6 and 100 Hz
Centre Frequency Range		2 Hz to 160 kHz	2 Hz to 20 kHz	0,2 Hz to 20 kHz	2 Hz to 20 kHz	10 Hz to 20 kHz
Sweep Type	Contiguous	Log	Log	–	–	
	Continuous	–	–	Log	~	Lin – Log
Automatic Sweep Control		Int. as well as Ext. via suitable Graphic Recorder	Ext. via suitable Graphic Recorder	Ext. via suitable Graphic Recorder	Automatically tracks and locks onto fundamental (or selected harmonic) of input signal	Ext. via Sine Generator Type 1023 or 1027, plus suitable Graphic Recorder
Suitable Graphic Recorders	Level	2306, 2307, 2309	2306, 2307, 2309	2306, 2309	2306, 2309	2307, 2309
	X – Y	2308	–	–	2308	2308
Max. Input Voltage		5 V pk.	5 V pk.	5 V pk.	4 V pk.	4,5 V pk.
Power Requirements		AC Mains	AC Mains	Int. Batt. – AC Mains$^{\Delta}$	Int. Batt. – AC Mains$^{\Delta}$	AC Mains

790690

Δ Accessory available

Table 4.1. B & K Filters for frequency analysis with the 2610

B & K Recorder Type		 2306	2307	 2308	 2309
Channels		1	1	X and Y	2
Rectifier		RMS	RMS-Average-Peak	—	RMS
Record Modes	Lin	DC	DC-AC (2 Hz to 200 kHz)	DC	DC
	Log	DC-AC (1,6 Hz to 20 kHz)	DC-AC (2 Hz to 200 kHz)	—	DC-AC (1,6 Hz to 20 kHz)
Record Range	Lin	0,3 mV to 2 V/mm	125 μV* to 1 V/mm	20 μV to 1 V/mm	0,3 mV to 2 V/mm
	Log	25 and 50 dB	10$^{\Delta}$, 25$^{\Delta}$, 50 and 75$^{\Delta}$ dB	—	25 and 50 dB
Record Paper	Rectilinear	50 mm wide	50 and 100 mm wide	A4 (DIN) size	2 x 50 mm wide
	Polar	—	200 mm diameter	—	—
Paper Speeds (or sweep speeds)		8 settings 0,01 to 30 mm/s	12 settings 0,0003 to 100 mm/s	9 settings (0,2 to 100 mm/s)	8 settings 0,01 to 30 mm/s
Writing Speeds (or slewing speed)		4 settings 16 to 250 mm/s	15 settings 2 to 2000 mm/s	(1000 mm/s max)	4 settings 16 to 250 mm/s
Synchronization		Int.-Ext. TTL Pulse	Mech. and Int.-Ext. Volt Ramp	Int.-Ext. Volt. Ramp	Int.-Ext. TTL Pulse Int. Volt. Ramp
Power Requirements		Int. Batt. — AC Mains$^{\Delta}$	AC Mains	AC Mains	Int. Batt. — AC Mains$^{\Delta}$

Δ Accessory available * Fixed DC offset of 5 mV

790691

Table 4.2. B & K Level and X-Y Recorders for use with the 2610

4.3. MAGNETIC TAPE RECORDING

B & K produce two portable magnetic tape recorders. Both are instrumentation types, one utilizing an FM record-reproduce technique, the other utilizing Audio and Direct techniques. They have the summarized specifications listed in Table 4.3 and are ideal for recording a wide variety of signals, both in the laboratory and in the field. Using the recorders, signals recorded in the field may be reproduced in the laboratory thus permitting detailed investigation and analysis using the 2610 and an external filter combination. Alternatively, signals measured with the 2610 may be recorded for storage and future reference purposes.

B & K Type	7003				7004			
Channels	4				2			
Record Modes	FM		Direct$^{\Delta}$		Audio		Direct	
Tape Speeds	1,5 ips	15 ips	1,5 ips	15 ips	7,5 ips	15 ips	1,5 ips	15 ips
Frequency Response	DC to 1 kHz (−1 dB)	DC to 12,5 kHz (−3 dB)	25 Hz to 5 kHz (±3 dB)	100 Hz to 50 kHz (±3 dB)	20 Hz to 18 kHz (±2 dB)	25 Hz to 20 kHz (±2 dB)	2,5 Hz* to 5 kHz (±3 dB)	25 Hz to 50 kHz (±3 dB)
Signal to Noise (Lin)	39 dB	44 dB	35 dB	39 dB	55 dB	55 dB	50 dB	50 dB
Tape Spool Size	7 inch diameter				7 inch diameter			
Power Requirements	Int. Batt. – AC Mains$^{\Delta}$				Int. Batt. – AC Mains$^{\Delta}$			

$^{\Delta}$ Accessory available * Record only

790689

Table 4.3. B & K portable Tape Recorders for use with the 2610

For tape recording measured signals, the use of the AC OUTPUT on the front panel of the 2610 is recommended. This produces a nominal output level of 1 V for FSD which matches the nominal record and reproduce level of the B & K Tape Recorders when these are used with their input sensitivity controls turned fully clockwise. Thus, provided that the nominal record level is kept at 1 V and the 1 V range of the 2610 is selected for measurement of the recorded signal on playback, then full scale meter deflection on playback will correspond to the full scale measurement range previously selected for recording. For example, if the 3 ms^{-2} range of the 2610 is selected for recording, then full scale deflection with the 1 V range selected for playback will correspond to 3 ms^{-2}.

Prior to recording measurements it is recommended that the internal or external reference used for calibrating the 2610 is recorded on tape. On playback this will allow accurate adjustment of the appropriate SENS. ADJ. potentiometer of the 2610 to compensate for small differences between recorded and reproduced signal amplitudes. For further information on the use of the B & K Tape Recorders, their Instruction Manuals should be consulted.

5. MEASUREMENT CHARACTERISTICS

5.1. OVERALL GAIN

The overall AC signal gain of the 2610 for various settings of its INPUT SECTION GAIN and OUTPUT SECTION GAIN knobs is given in Table 5.1. The dB values specified are the exact overall gain (± 0,05 dB) from the DIRECT (or PREAMP.) INPUT to the 1 V FSD AC OUTPUT of the instrument when calibrated using its internal reference voltage as described in section 3.4.1. When the 1.6 V FSD AC OUTPUT is used, the gain is 4 dB higher. If necessary an extra 0 to + 10 dB of continuous gain adjustment can be obtained by turning the INPUT GAIN knob from its click-stop "Cal." position.

		INPUT SECTION GAIN (dB)								
		−30	−20	−10	0	10	20	30	40	50
OUTPUT SECTION GAIN (dB)	0	−30	−20	−10	0	10	20	30	40	50
	10	−20	−10	0	10	20	30	40	50	60
	20	−10	0	10	20	30	40	50	60	70
	30	0	10	20	30	40	50	60	70	80
	40	10	20	30	40	50	60	70	80	90
	50	20	30	40	50	60	70	80	90	100
		Overall Gain (dB)								

790692

Table 5.1. Overall AC signal gain from the DIRECT (or PREAMP.) INPUT to the 1 V FSD AC OUTPUT of the 2610

5.2. FREQUENCY RESPONSE

The overall frequency response of the 2610 with and without its internal "22,4 Hz" High Pass and "A" Weighting networks selected is shown in Fig.5.1. As indicated, without internal filter networks selected the frequency response is linear to within ± 0,5 dB from 2 Hz up to 200 kHz. For a well defined upper limiting frequency response, the record amplifier feeding the 1,6 V FSD AC OUTPUT and the detector stages of the 2610 has a 315 kHz low pass filter permanently connected giving a high frequency attenuation slope of 18 dB/octave (60 dB/decade). The effective noise bandwidth (i.e. bandwidth of ideal filter which would pass the same white noise power as the specified practical filter) of the linear and weighted response modes of the 2610 and of other B & K instruments, is specified in Table 5.2.

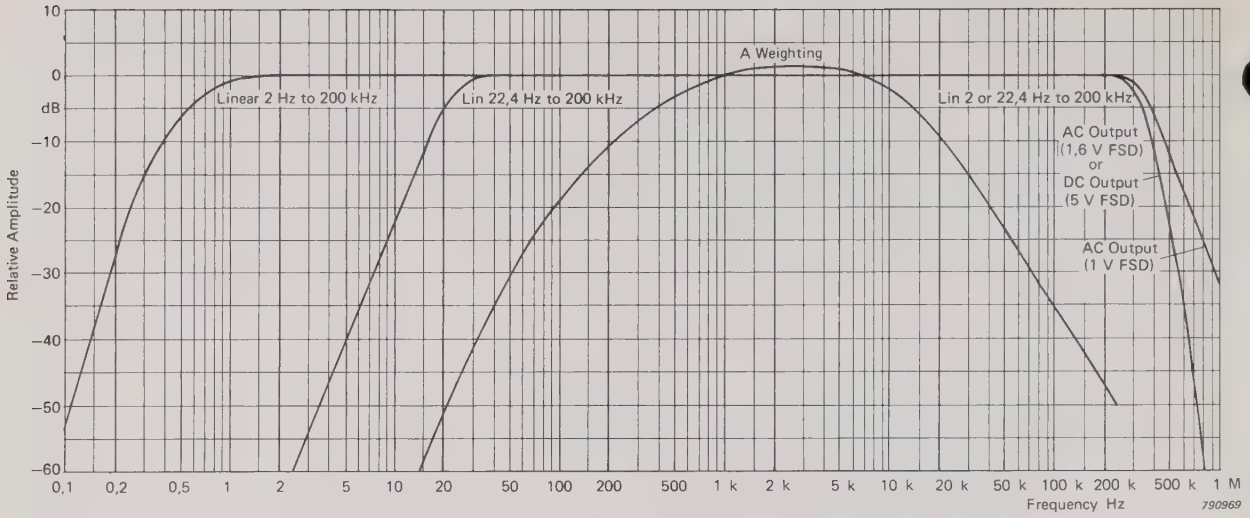


Fig.5.1. Typical overall frequency response of the 2610

Filter Mode	Effective Noise Bandwidth
Lin. 2 Hz to 200 kHz	300 kHz
Lin. 22,4 Hz to 200 kHz	300 kHz
Lin. 2 or 22,4 Hz to 22,4 kHz	23 kHz
A Weighting	13,5 kHz
B Weighting	9,7 kHz
C Weighting	9,7 kHz
D Weighting	77,2 kHz

790693

Table 5.2. Effective noise bandwidth with the standardized linear and weighted response modes of B & K instruments

5.3. PHASE RESPONSE

The overall phase response of the 2610 is shown in Fig.5.2. For measurements involving the use of the Lin 2 Hz to 200 kHz mode and 1 V FSD AC OUTPUT, the phase deviation at frequencies from 20 Hz up to 20 kHz is of the order of ± 15° (typical), while the maximum phase deviation between any two 2610's is ± 5° at frequencies from 20 Hz up to 20 kHz.

As far as measurements of RMS levels are concerned, the phase response of the 2610 has no influence on its measurement accuracy. However, it can distort the waveform of complex signals preventing accurate measurement of peak levels at low and high frequencies. The influence of this distortion on a symmetrical square wave signal such as reproduced by the 2610 is illustrated in Fig.5.3.

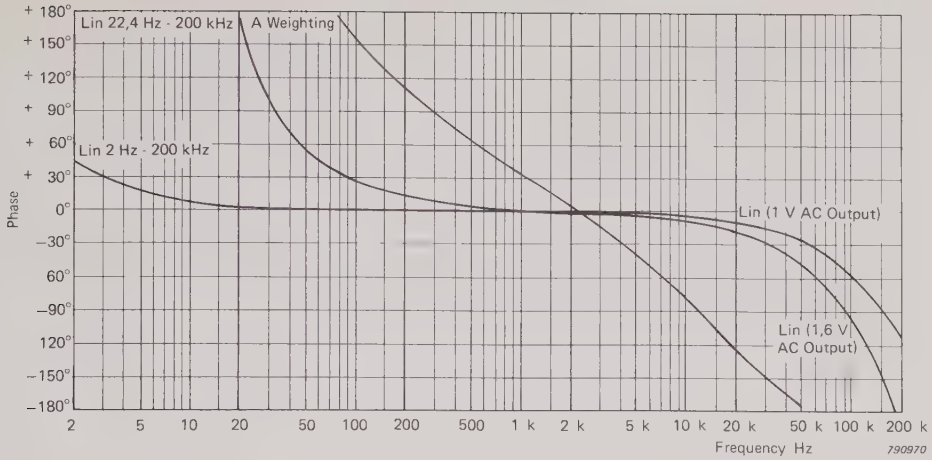


Fig.5.2. Typical overall phase response of the 2610

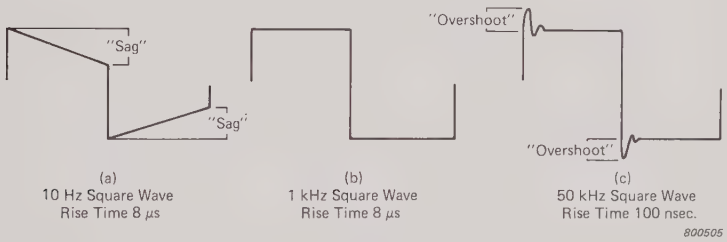


Fig.5.3. Influence of phase distortion on symmetrical square wave signal

Fig.5.3(a) illustrates the effect of "sag". This occurs as a result of low frequency components of complex signals phase leading their fundamental. For measurement of square wave and other types of complex periodic signal with the 2610, essentially sag-free reproduction with peak indicating accuracy of 0,5 dB, can be obtained at frequencies greater than 100 Hz.

Fig.5.3(c) shows the effect of "overshoot" which occurs as a result of high frequency signal components phase lagging their fundamental. With the 2610, signals with rise times as short as 8 μs may be applied without significant overshoot being introduced. However, for accurate measurements using the Peak Detector of the instrument the rise time should be greater than 50 μs (i.e. 1,7 dB/μs).

5.4. NOISE AND DYNAMIC RANGE

A third octave analysis of internal noise produced by the input and output amplifier sections of the 2610, is shown in Fig.5.4. This was measured with the DIRECT INPUT short circuited and the controls of the instrument set for maximum overall gain. For non selective measurements using the Linear 2 to 200000 Hz mode, the typical noise level referred to input is 3,16 μV_{RMS} — 15 μV_{Peak}, which with an INPUT and OUTPUT SECTION GAIN of "0 dB" selected, give a corresponding signal to noise ratio (maximum output signal level V_{Peak} / Output noise level $V_{RMS\ or\ Peak}$) of 100 dB (RMS) or 86 dB (Peak). For other INPUT and OUTPUT SECTION GAIN settings, the signal to noise ratio is of the order specified in Table 5.3.

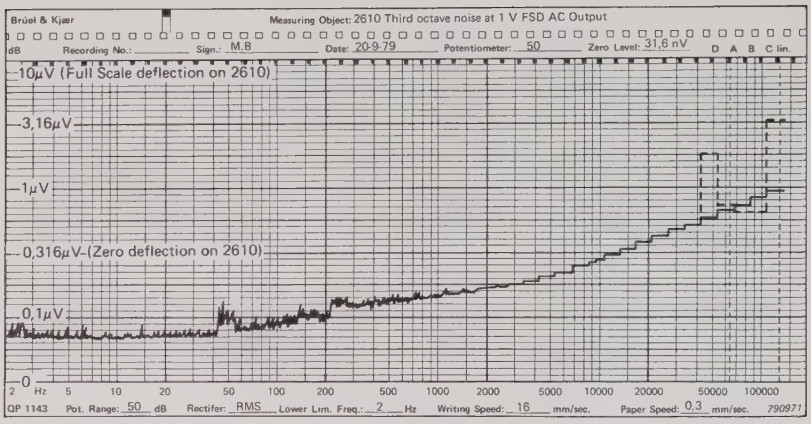

Brüel & Kjær
Measuring Object: 2610 Third octave noise at 1 V FSD AC Output
dB Recording No.: Sign.: M.B Date: 20-9-79 Potentiometer: 50 Zero Level: 31,6 nV D A B C lin.
10μV (Full Scale deflection on 2610)
3,16μV
1μV
0,316μV-(Zero deflection on 2610)
0,1μV
0
2 Hz 5 10 20 50 100 200 500 1000 2000 5000 10000 20000 50000 100000
QP 1143 Pot. Range: 50 dB Rectifer: RMS Lower Lim. Freq.: 2 Hz Writing Speed: 16 mm/sec. Paper Speed: 0,3 mm/sec. 790971

Fig.5.4. Typical third octave analysis of internal noise produced by the 2610 with its input short circuited

OUTPUT SECTION GAIN (dB)	INPUT SECTION GAIN (dB) −30	−20	−10	0	10	20	30	40	50
0	101 (87)	100 (86)	101 (87)	100 (86)	101 (87)	100 (86)	96 (82)	87 (73)	77 (63)
10	92 (78)	91 (77)	91 (77)	90 (76)	92 (78)	91 (77)	87 (73)	77 (63)	67 (53)
20	82 (68)	82 (68)	82 (68)	81 (67)	82 (68)	82 (68)	77 (63)	67 (53)	57 (43)
30	72 (58)	72 (58)	72 (58)	71 (57)	72 (58)	72 (58)	67 (53)	57 (43)	47 (33)
40	62 (48)	62 (48)	62 (48)	61 (47)	62 (48)	62 (48)	57 (43)	47 (33)	38 (24)
60	53 (38)	52 (38)	52 (38)	51 (37)	53 (39)	52 (38)	47 (33)	38 (24)	30 (16)

Signal to Noise ratio dB – RMS (and Peak) noise floor

790687

Table 5.3. Typical signal to noise ratio available with the AC OUTPUTs of the 2610 when the linear 2 Hz to 200 kHz or 22,4 Hz to 200 kHz mode is selected

OUTPUT SECTION GAIN (dB)	INPUT SECTION GAIN (dB)								
	−30	−20	−10	0	10	20	30	40	50
0	104 (90)	103 (89)	103 (89)	103 (89)	104 (90)	103 (89)	102 (88)	97 (83)	88 (74)
10	97 (83)	96 (82)	96 (82)	96 (82)	97 (83)	96 (82)	95 (81)	88 (74)	78 (64)
20	88 (74)	87 (73)	87 (73)	85 (71)	88 (74)	87 (73)	85 (71)	78 (64)	68 (54)
30	78 (64)	77 (63)	77 (63)	75 (61)	78 (64)	78 (64)	75 (61)	68 (54)	58 (44)
40	68 (54)	67 (53)	67 (53)	65 (51)	68 (54)	68 (54)	65 (51)	58 (44)	48 (34)
50	59 (43)	58 (44)	56 (42)	56 (42)	58 (44)	58 (44)	55 (41)	48 (34)	38 (24)

Signal to Noise Ratio dB — RMS (and Peak) noise floor

790688

Table 5.4. Typical signal to noise ratio available with the AC OUTPUTs of the 2610 when the A-weighting mode is selected

The signal to noise ratio of the 2610 may be effectively increased by reducing its measurement bandwidth. This may be done using its internal A-weighting network or by employing external filters. With A-weighting selected, high frequency noise components are attenuated, which as indicated in Table 5.4 increases the signal to noise by up to 8 dB when using the high gain settings of the instrument. For measurements using third octave filters, a similar if not greater increase can be obtained. See Fig.5.4.

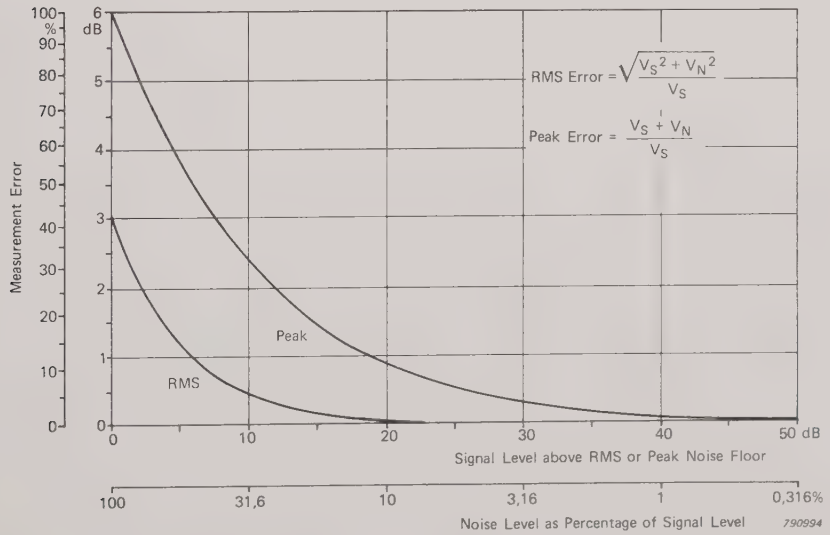


Fig.5.5. RMS and Peak measurement accuracy as a function of signal or measurement system noise level

The influence of signal and measurement system noise on the measurement accuracy of the 2610 and of other instruments with which it may be used, is shown in Fig.5.5. For RMS measurements, the minimum detectable signal level for 0,5 dB accuracy, is approximately 9 dB above the noise floor. Consequently, for recording of RMS levels it is important that a measurement bandwidth and gain setting be selected that give a signal to noise ratio 9 dB greater than the dynamic range (maximum signal level/minimum detectable signal level) required for recording. Similarly, for recording of peak levels with 0,5 dB accuracy, a signal to noise ratio approximately 25 dB greater than the required dynamic range should be selected. See Tables 5.3 and 5.4, as well as Fig.5.6.

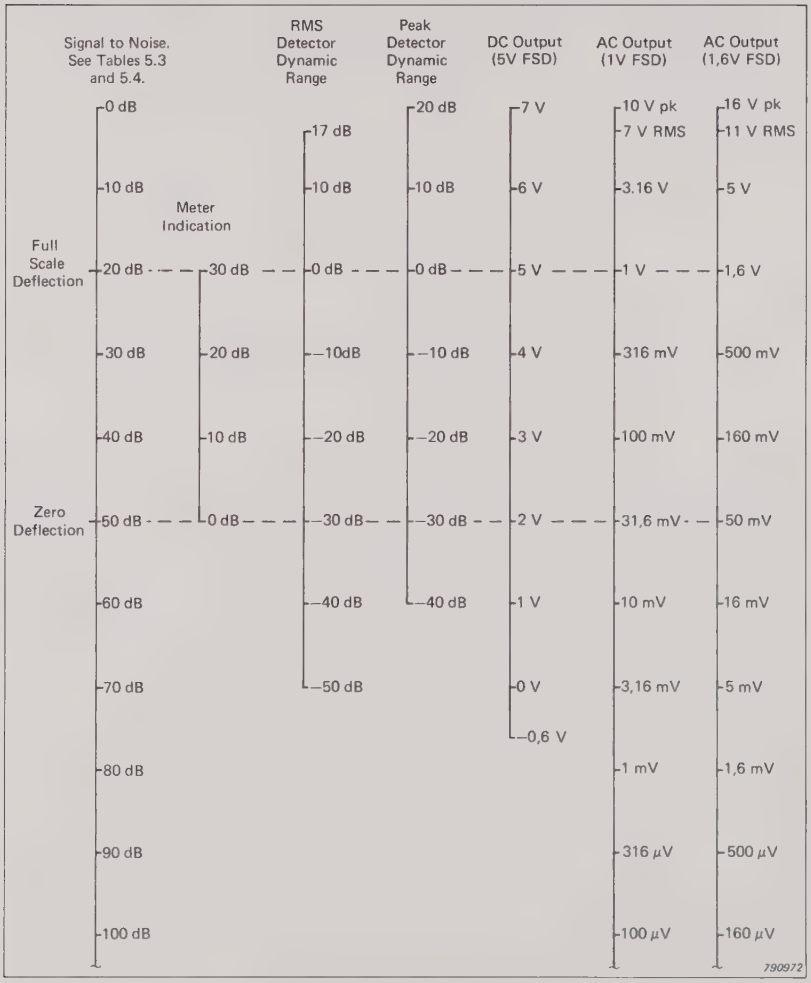
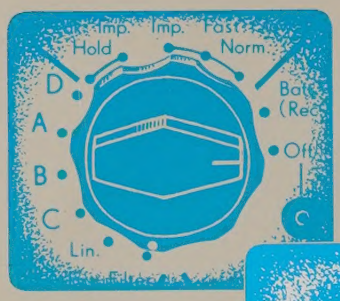
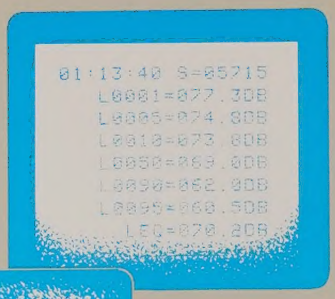


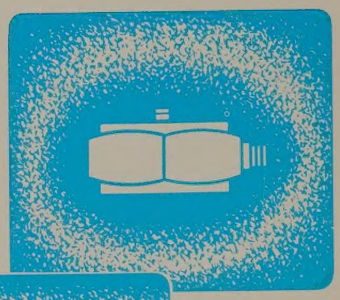
Fig.5.6. Signal level, signal to noise ratio and dynamic range available with the AC and DC OUTPUTs of the 2610

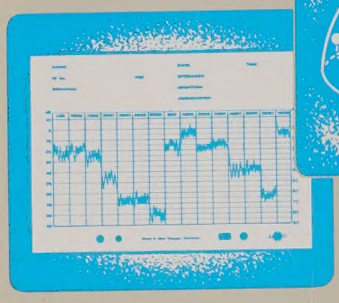
6. SERVICE AND REPAIR

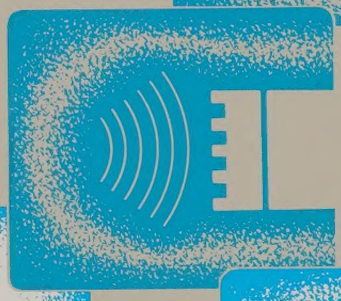
The 2610 is designed and constructed to provide the user with many years of safe, trouble free operation. However, should a fault occur which impairs its correct function and operating safety, then it should be immediately disconnected at the mains source and be secured against unintended operation. For repair consult the separate Service Instruction Manual available for the 2610 or contact your local B & K service representative. Under no circumstances should repair be attempted by persons not qualified in the service of electronic instrumentation.

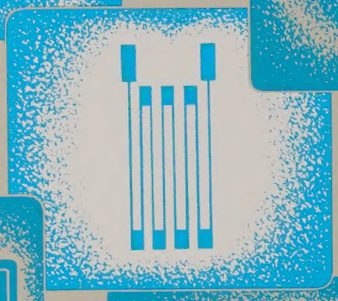


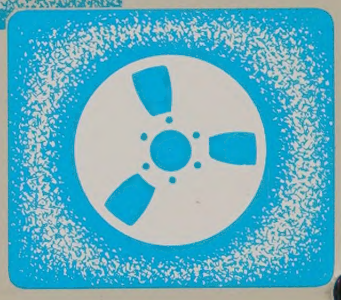


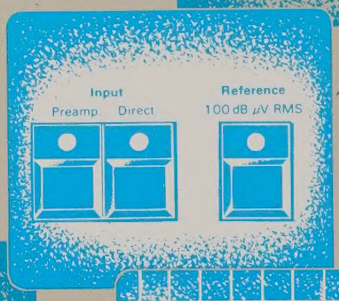


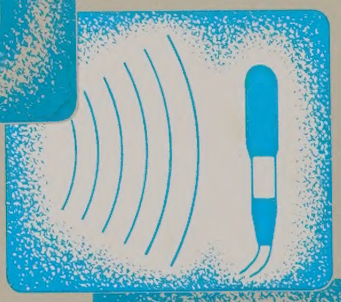


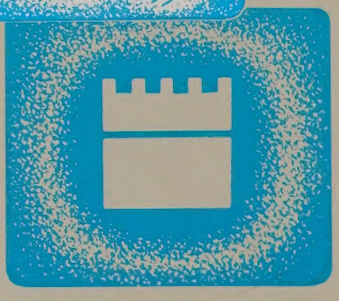


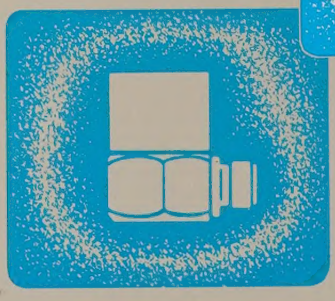


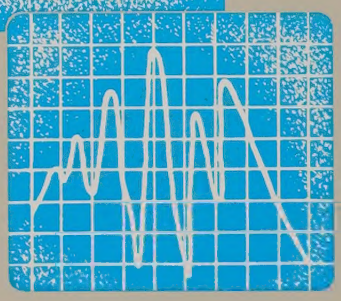












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